Poritosh Dey(Person1) (Lead Researcher) - Phase 0 Complete Work Report

Project: Quantum-Enhanced AI for Autonomous Network Self-Healing

Date: 10/12/25
Phase: 0 - Development Environment Setup
Status: ☑ 100% COMPLETE

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1. EXECUTIVE SUMMARY

As Person 1 (Lead Researcher), I have successfully established the complete development environment for our quantum-enhanced network self-healing project. The foundation is now ready for Phase 1 development work.

2. COMPLETED TASKS

2.1 Ubuntu System Configuration

Commands Executed:

```
bash
sudo apt update && sudo apt upgrade -y
sudo apt install -y build-essential curl wget git
sudo apt install -y python3 python3-venv python3-pip
sudo apt install python-is-python3
```

What Was Achieved:

- ☑ Updated Ubuntu system packages to latest versions
- ☑ Installed essential development tools (compilers, git, etc.)
- ☑ Installed Python 3.10.12 with virtual environment support
- ☑ Fixed `python` command issue (now points to `python3`)

2.2 Project Structure Creation

Commands Executed:

```bash
cd ~
mkdir my_project
cd my_project
```

Created Folder Structure:

```text
my_project/
├── venv/                          # Virtual Environment
├── src/                           # All Source Code
│   ├── models/                    # QML Models (My Phase 1 work)
│   │   └── phase1/                # Phase 1 specific code
│   ├── utils/                     # Helper Functions
│   └── data_processing/           # Person 3's work area
├── config/                        # Configuration Files
├── notebooks/                     # Jupyter Notebooks for experiments
├── tests/                         # Test Cases
├── logs/                          # Log Files
├── docs/                          # Documentation
└── team_handover/                 # Files for team members
```

2.3 Virtual Environment Setup

Commands Executed:

```bash
python3 -m venv venv
source venv/bin/activate
```

What Was Achieved:

- ☑ Created isolated Python environment (`venv`)
- ☑ Activated virtual environment (terminal shows `(venv)`)
- ☑ Ensures project dependencies don't conflict with system packages

2.4 Core Libraries Installation

Commands Executed:

```
bash
pip install --upgrade pip
pip install qiskit qiskit-machine-learning pennylane
pip install flwr networkx pandas numpy scikit-learn
pip install pyyaml jupyter pytest
pip install qiskit-aer
```

Installed Libraries & Versions:

Library	Version	Purpose
qiskit	1.4.5	Quantum Computing Framework
qiskit-machine-learning	0.7.0	Quantum Machine Learning
pennylane	Latest	Alternative Quantum ML
flwr (Flower)	1.24.0	Federated Learning Framework
networkx	3.4.2	Network Analysis & Simulation
pandas	2.3.3	Data Processing
numpy	2.2.6	Numerical Computing
scikit-learn	1.7.2	Machine Learning Algorithms
pyyaml	6.0.3	Configuration File Handling
jupyter	Latest	Interactive Notebooks
pytest	Latest	Testing Framework

2.5 Networking Tools Installation

Commands Executed:

bash

```bash
sudo apt install -y mininet
```

What Was Achieved:

- ☑ Installed Mininet 2.3.0 for network simulation
- ☑ Can create virtual networks for testing
- ☑ Supports SDN (Software Defined Networking) simulations

2.6 Configuration Management Setup

Created File: `config/default_config.yaml`

yaml

```yaml
project:
  name: "Quantum-Network-SelfHealing"
  version: "1.0.0"
  python_version: "3.10"

quantum:
  backend: "aer_simulator"
  shots: 1024
  optimization_level: 1

ml:
  test_size: 0.2
  random_state: 42
  epochs: 100

network:
  mininet_simulator: true
  default_topology: "tree"
```

2.7 Verification System Creation

Created File: `verify_phase0.py`

python

```python
#!/usr/bin/env python3
import sys, subprocess, yaml, pkg_resources

def check_package(pkg_name):
    try:
        version = pkg_resources.get_distribution(pkg_name).version
        return f"✅ {pkg_name:25} v{version}"
    except:
        return f"❌ {pkg_name:25} NOT FOUND"

print("="*60)
print("PHASE 0 VERIFICATION - PERSON 1 (Lead Researcher)")
print("="*60)

# Verification checks...
# [Full code available in project]
```

What It Verifies:

1. ✅ Python version
2. ✅ All core packages installation
3. ✅ Virtual environment activation
4. ✅ Configuration file loading
5. ✅ Mininet installation

2.8 Dependencies Documentation

Commands Executed:

```
bash
pip freeze > requirements.txt
```

Created File: `requirements.txt` (contains exact versions of 25+ packages)

2.9 Test Files Creation

Created Files:

1. `test_setup.py` - Basic Python environment test
2. `test_config.py` - Configuration loading test

3. `test_quantum.py` - Quantum circuit test

2.10 Git Repository Setup

Commands Executed:

```bash
git init
git config --global user.name "YourName"
git config --global user.email "youremail@example.com"
git add .
git commit -m "Phase 0: Complete development environment setup"
```

3. TECHNICAL SPECIFICATIONS

3.1 System Requirements Met

- **OS:** Ubuntu 22.04 LTS
- **Python:** 3.10.12
- **RAM:** 4GB minimum (8GB recommended for quantum simulations)
- **Storage:** ~5GB used for environment

3.2 Quantum Computing Stack

- **Framework:** Qiskit 1.4.5 (IBM)
- **Simulator:** Qiskit Aer (local quantum circuit simulation)
- **Quantum ML:** Qiskit Machine Learning 0.7.0
- **Alternative:** PennyLane (for hybrid quantum-classical models)

3.3 Machine Learning Stack

- **Classical ML:** Scikit-learn 1.7.2
- **Federated Learning:** Flower 1.24.0
- **Deep Learning:** TensorFlow/PyTorch ready (can be added)

3.4 Networking Stack

- **Simulation:** Mininet 2.3.0
- **Analysis:** NetworkX 3.4.2
- **Protocols:** Ready for SDN, OpenFlow simulations

4. VERIFICATION RESULTS

Running `python verify_phase0.py` gives:

```
text
============================================================
PHASE 0 VERIFICATION - PERSON 1 (Lead Researcher)
============================================================

[1] Python Version: 3.10.12

[2] Core Packages:
    ☑ qiskit                    v1.4.5
    ☑ flwr                      v1.24.0
    ☑ networkx                  v3.4.2
    ☑ pandas                    v2.3.3
    ☑ numpy                     v2.2.6
    ☑ scikit-learn              v1.7.2

[3] Virtual Environment:
    ☑ Active

[4] Configuration File:
    ☑ Loaded: Quantum-Network-SelfHealing v1.0.0

[5] Mininet Installation:
    ☑ Mininet Installed

============================================================
VERIFICATION COMPLETE - READY FOR PHASE 1
============================================================
```

5. CHALLENGES SOLVED

5.1 Python Command Issue

Problem: `python` command not found
Solution: Installed `python-is-python3` package
Command: `sudo apt install python-is-python3`

5.2 Virtual Environment Packages Missing

Problem: Packages installed in global Python, not in venv
Solution: Activated venv and reinstalled all packages
Command: `source venv/bin/activate && pip install -r requirements.txt`

5.3 YAML Module Missing

Problem: `ModuleNotFoundError: No module named 'yaml'`
Solution: Installed `pyyaml` package
Command: `pip install pyyaml`

5.4 File Location Confusion

Problem: Files created in wrong directory
Solution: Used `pwd` to check location, moved files correctly
Command: `cp ~/verify_phase0.py .`

6. DELIVERABLES PRODUCED

6.1 Core Files

1. ☑ `requirements.txt` - Complete dependency list
2. ☑ `verify_phase0.py` - Setup verification script
3. ☑ `config/default_config.yaml` - Project configuration
4. ☑ `.git/` - Version control initialized

6.2 Test Files

1. ☑ `test_setup.py` - Basic environment test

2. ☑ `test_config.py` - Config file loader test
3. ☑ `test_quantum.py` - Quantum circuit test

6.3 Documentation

1. ☑ Project structure documentation
2. ☑ Setup instructions
3. ☑ Troubleshooting guide

7. READY FOR PHASE 1

7.1 Environment Status

- ☑ All quantum computing tools ready
- ☑ ML/FL frameworks installed
- ☑ Networking simulation tools ready
- ☑ Testing framework configured
- ☑ Documentation structure created

7.2 Next Steps (Phase 1 - My Tasks)

1. **QML Architecture Design** in `src/models/phase1/`
2. **Quantum Feature Encoding** circuits design
3. **QSVM/QBM Model Selection** and implementation
4. **Theoretical Performance Analysis**

7.3 Team Ready Status

- Person 1 (Me): ☑ Environment ready, starting Phase 1
- Person 2: Can start documentation in `docs/` folder
- Person 3: Can start data pipeline in `src/data_processing/`

8. TECHNICAL NOTES

8.1 Key Directories

- **Code Development:** `~/my_project/src/`
- **Experiments:** `~/my_project/notebooks/`
- **Configuration:** `~/my_project/config/`
- **Testing:** `~/my_project/tests/`

8.2 Daily Workflow

```bash
# Start work session:
cd ~/my_project
source venv/bin/activate

# End work session:
deactivate
```

8.3 Important Commands

```bash
# Check environment:
python verify_phase0.py

# Update dependencies:
pip freeze > requirements.txt

# Run tests:
pytest tests/

# Quantum circuit test:
python test_quantum.py
```

9. CONCLUSION

Phase 0 has been successfully completed with 100% of objectives achieved. The development environment is fully configured, tested, and ready for quantum machine learning development. All team members can now clone this environment and begin their respective Phase 1 tasks.

Total Time Invested: Approximately 3-4 hours
Lines of Code Written: ~200 lines across various scripts
Packages Installed: 25+ Python packages
Files Created: 15+ configuration, test, and setup files

Prepared by: Poritosh Dey (Lead Researcher)
Date: 10/12/25